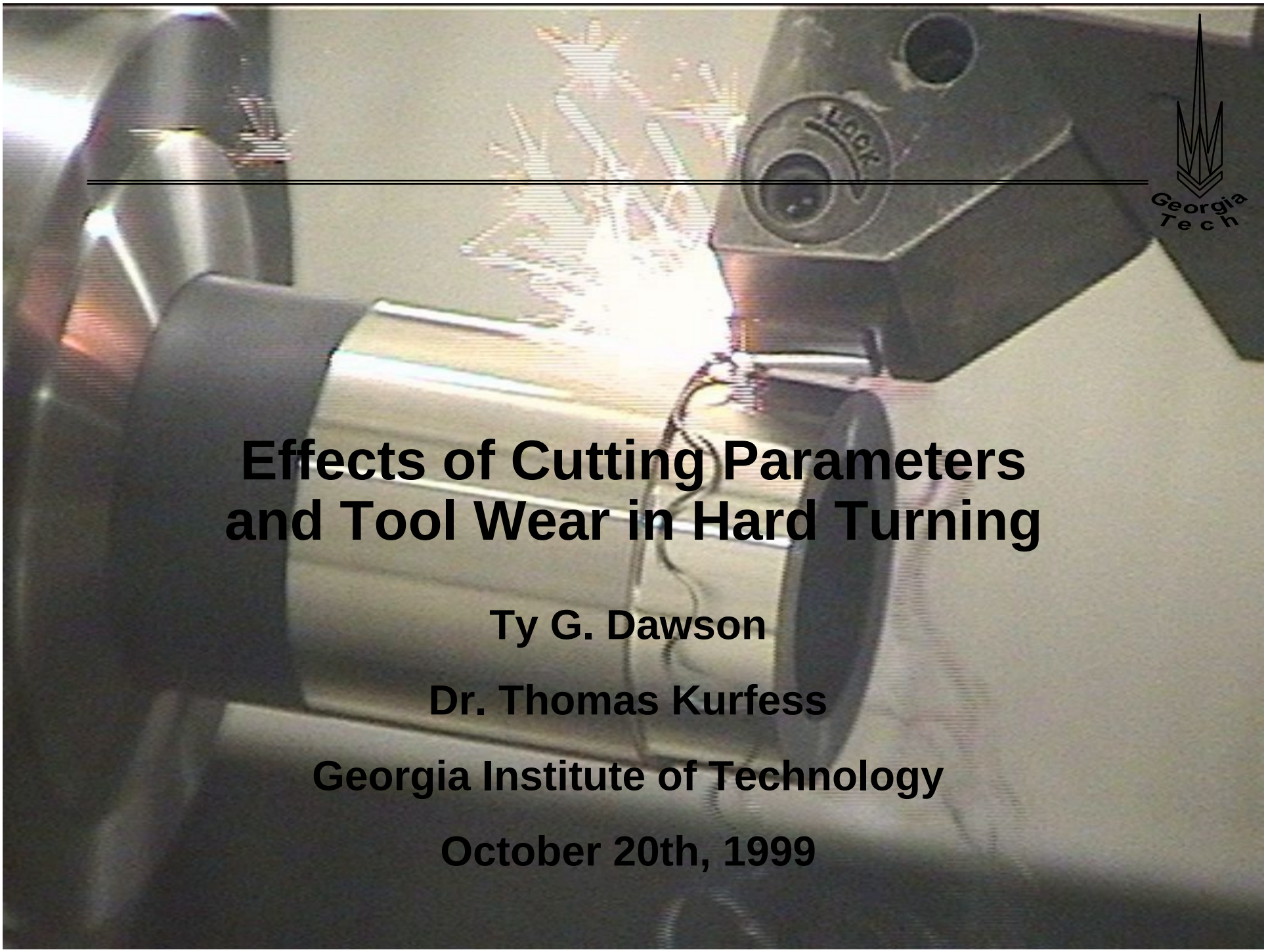

Effects of Cutting Parameters and Tool Wear in Hard Turning

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Presentation Outline

- Brief background/intro to hard turning
- Experimental results
- Conclusions and recommendations

What is hard turning?

- Turning “hard” material
- “Hard” is arbitrarily defined above 45 HRC
- Some materials may be up to 70 HRC
- Typical materials
  - Heat treated steels
  - Case hardened steels
- Cutting tools
  - Carbide
  - Ceramics (Al_2O_3 and TiC)
  - Cubic Boron Nitride (CBN)

Importance of hard turning

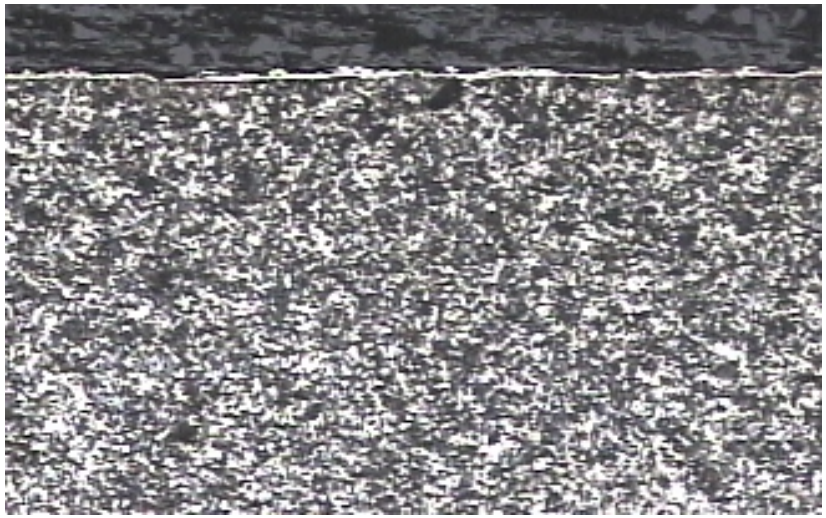
- Industry is very interested
- Hard turning may replace many grinding operations
  - Increased flexibility
  - Decreased cycle times
  - Decreased number of machine tools
  - Less expensive machine tools
  - Significantly decreased setup times
  - Environmentally friendly (dry cutting)

So why doesn't everyone hard turn?

- Rigid machine tools and cutting inserts have just recently made this process feasible
- Advantages of "centerless" grinding are still significant
- Tool costs can be expensive if tool life is short
- Surface finish and geometry is still questionable
- Surface integrity has been a problem

Research Objective

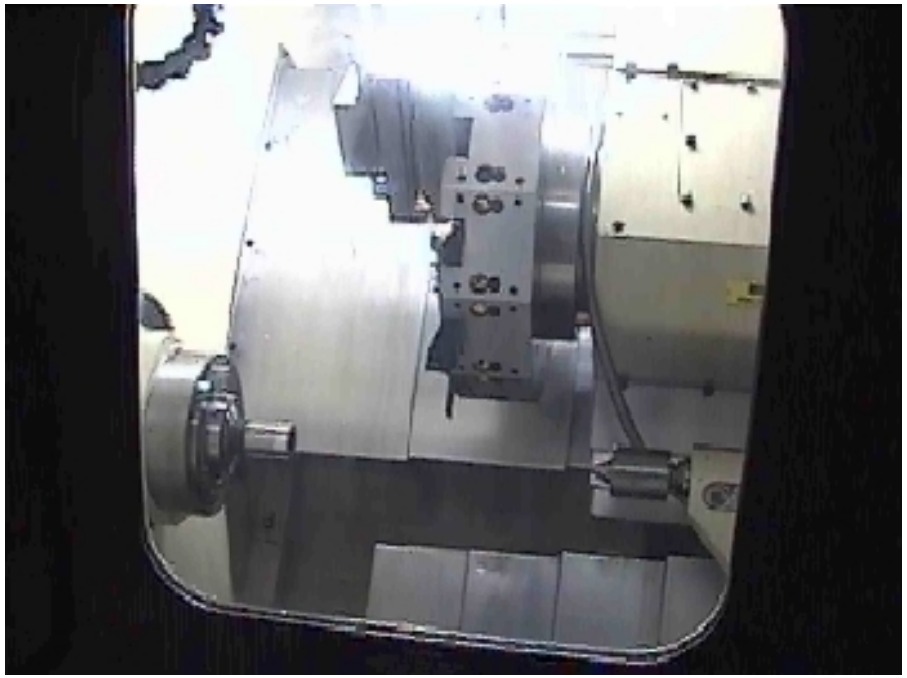
- Determine the effect of varying cutting conditions
  - cutting forces
  - tool wear
  - “white layer”
  - surface finish



Test Conditions

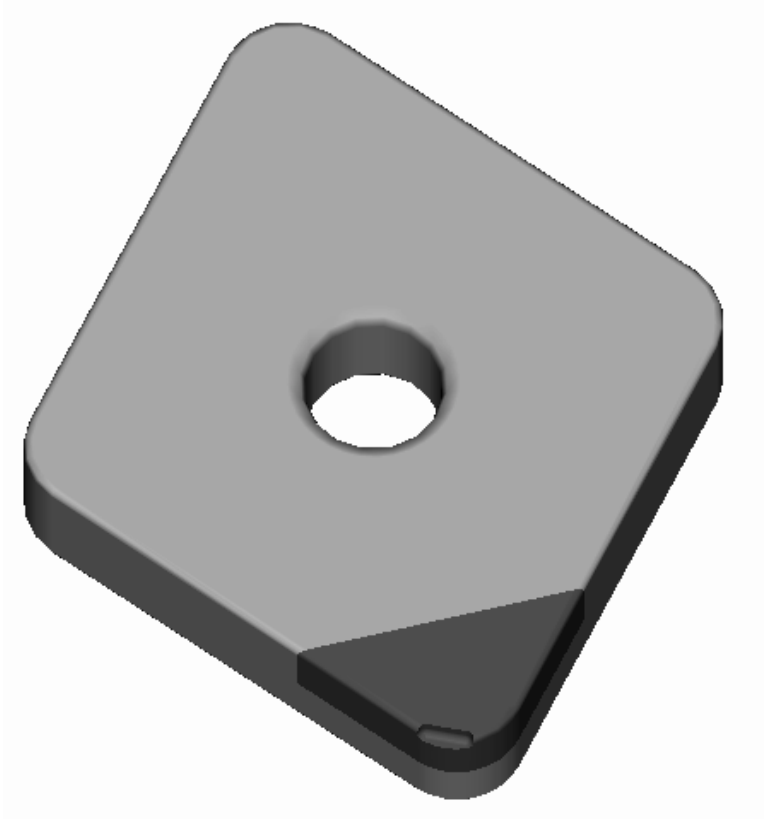
Cutting condition	Radial depth of cut	Cutting speed	Feed rate
1	0.203 mm	182.9 m/min	0.152 mm/rev
2	0.203 mm	91.4 m/min	0.076 mm/rev
3	0.203 mm	91.4 m/min	0.076 mm/rev
4	0.203 mm	182.9 m/min	0.152 mm/rev
5	0.508 mm	182.9 m/min	0.152 mm/rev
6	0.203 mm	182.9 m/min	0.152 mm/rev
1	0.008 in	600 ft/min	0.006 in/rev
2	0.008 in	300 ft/min	0.003 in/rev
3	0.008 in	300 ft/min	0.006 in/rev
4	0.008 in	600 ft/min	0.003 in/rev
5	0.020 in	600 ft/min	0.006 in/rev
6	0.008 in	600 ft/min	0.006 in/rev

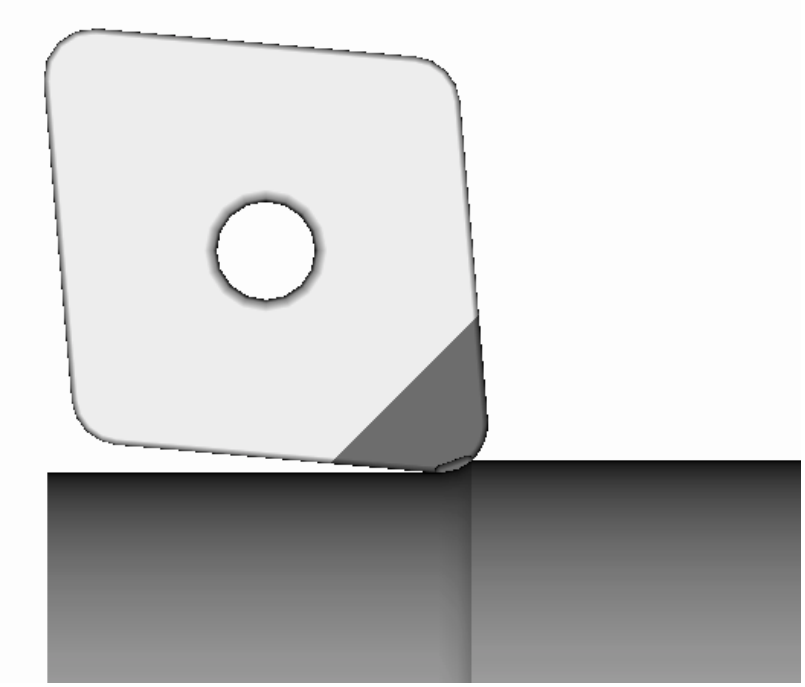
Experimental Demonstration



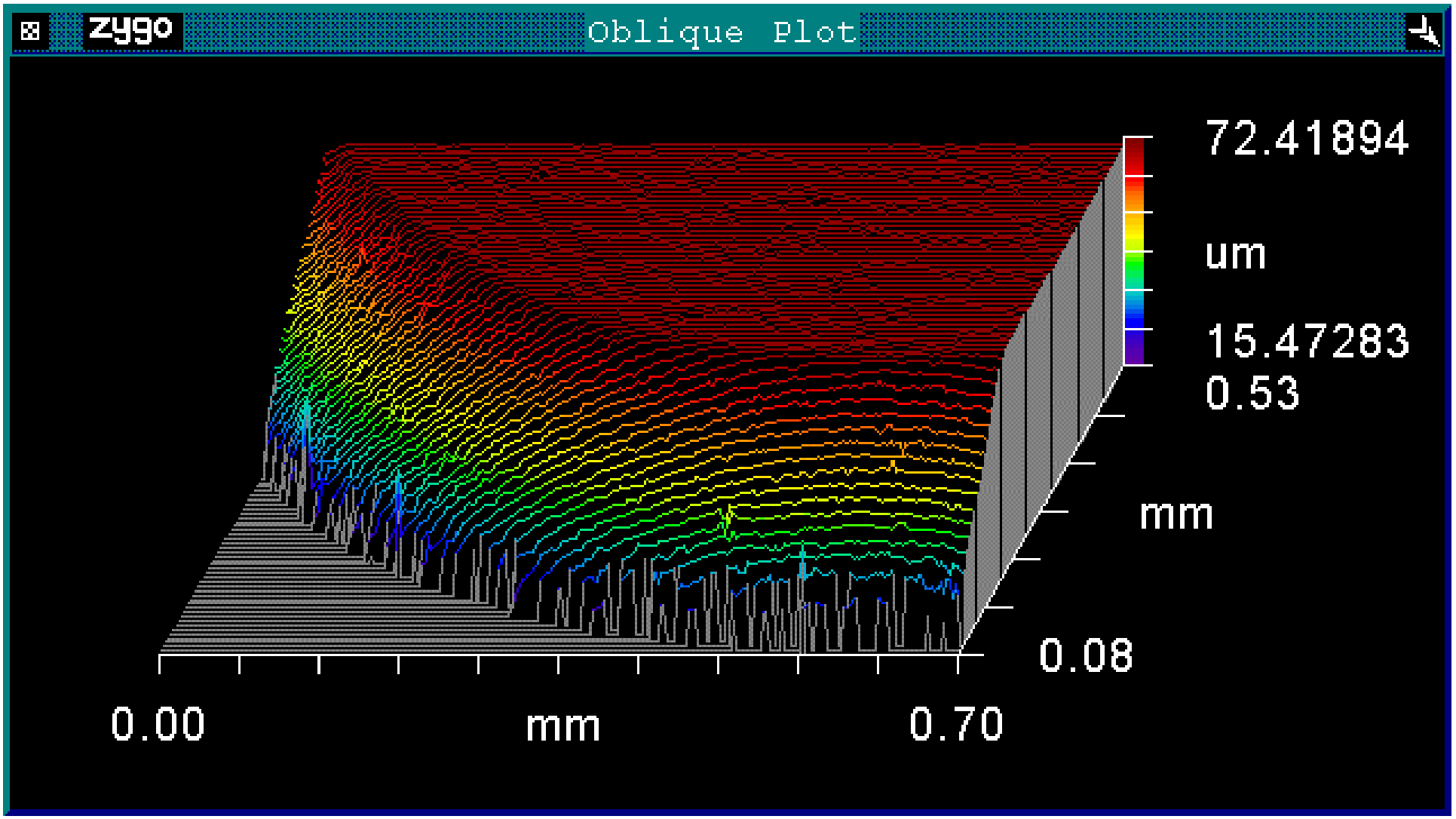
Tool Wear Results

- Tool wear occurs on nose radius of the tool
- At a 0.203mm (0.008”) depth of cut, the cut also occurs primarily on the 20° chamfer

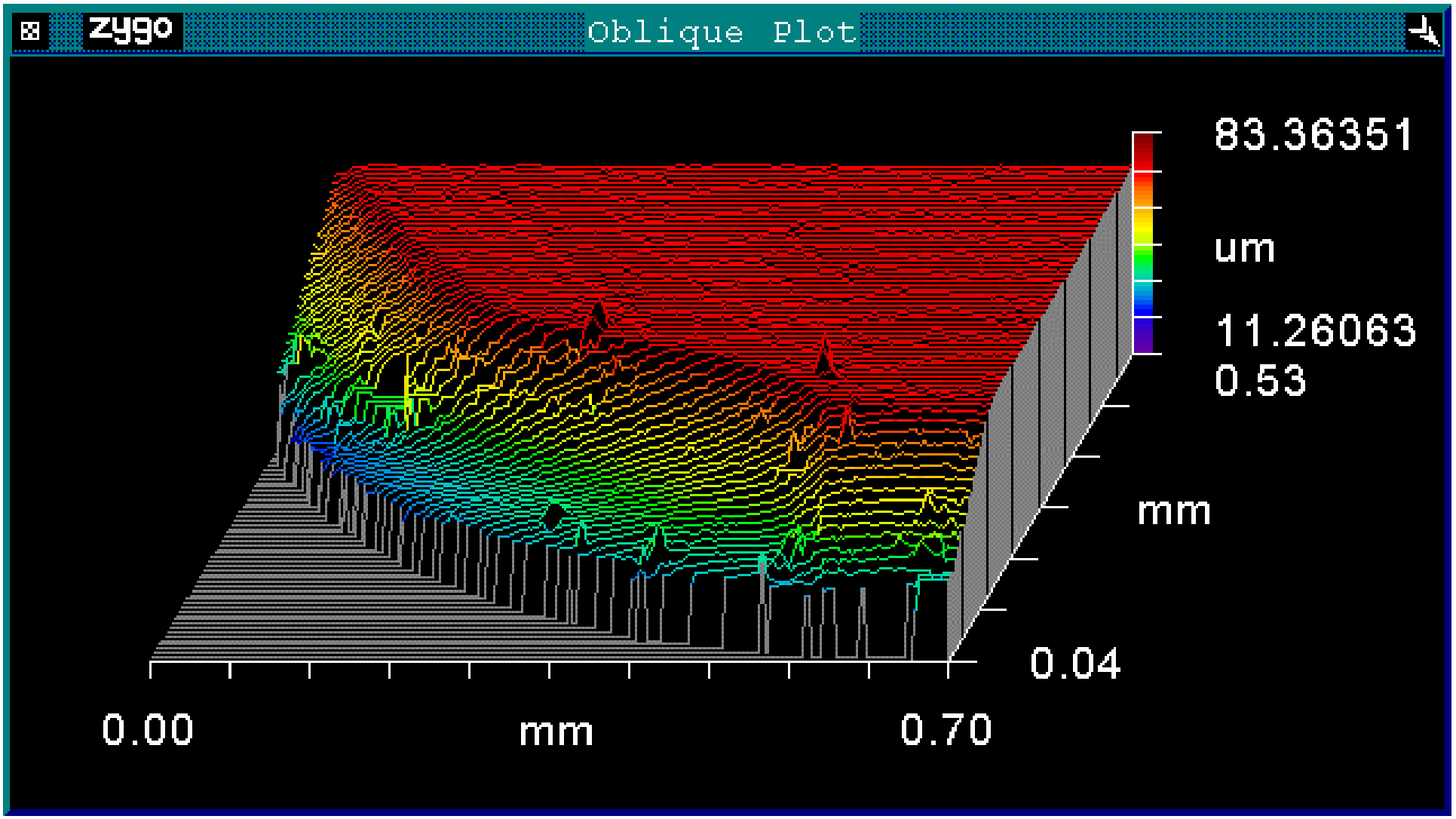




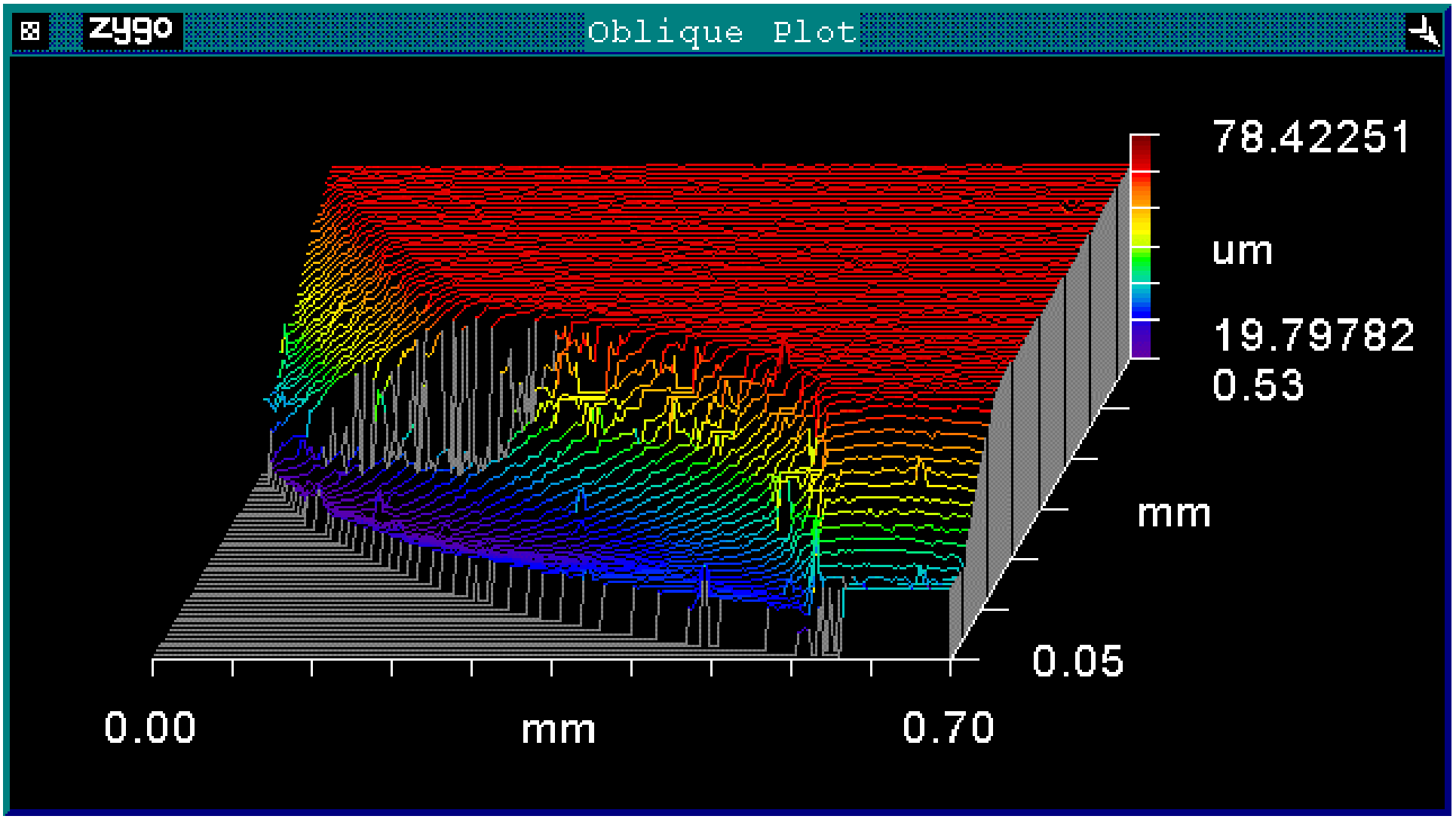
Progression of Crater Wear



Progression of Crater Wear



Progression of Crater Wear



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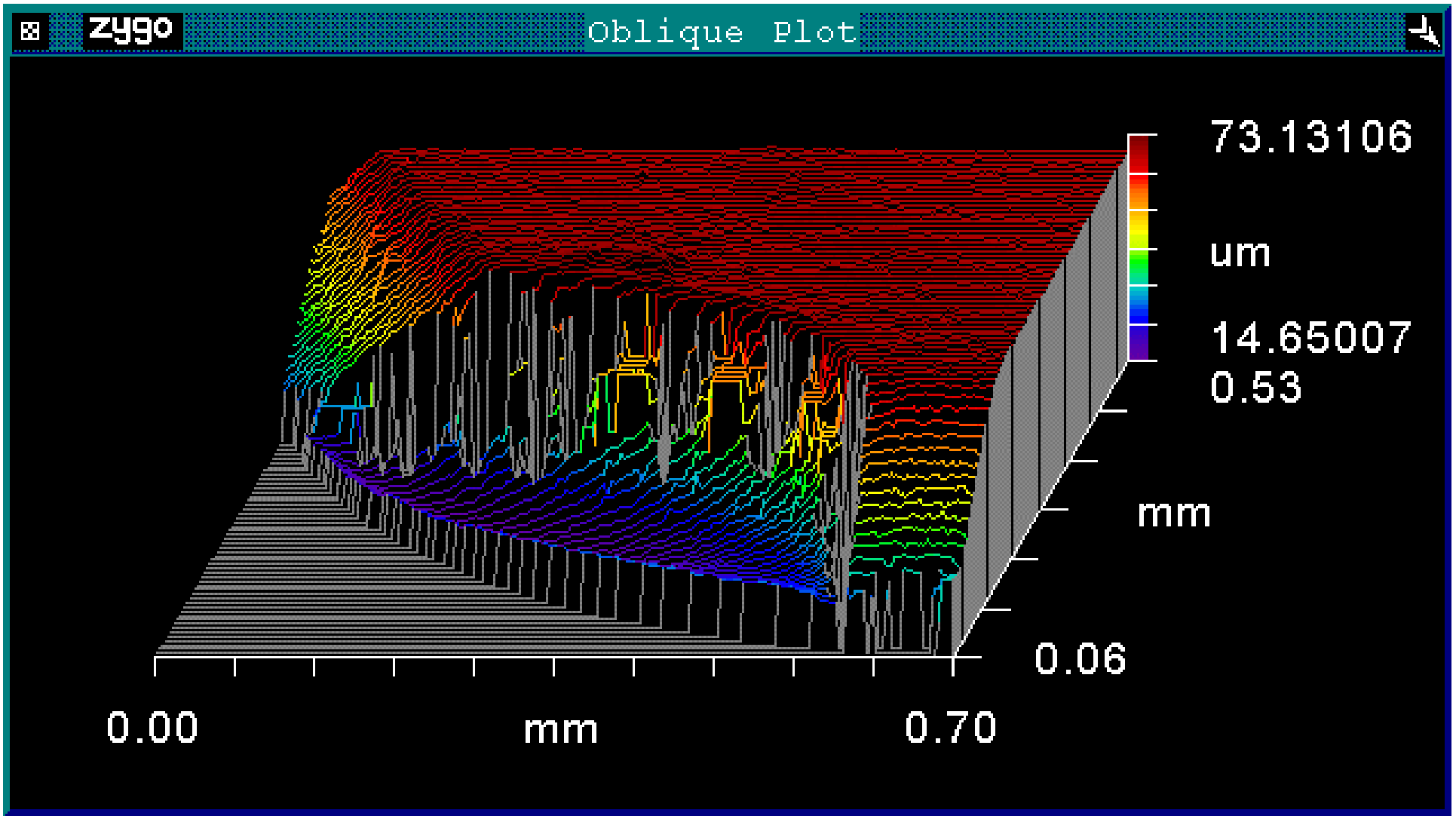

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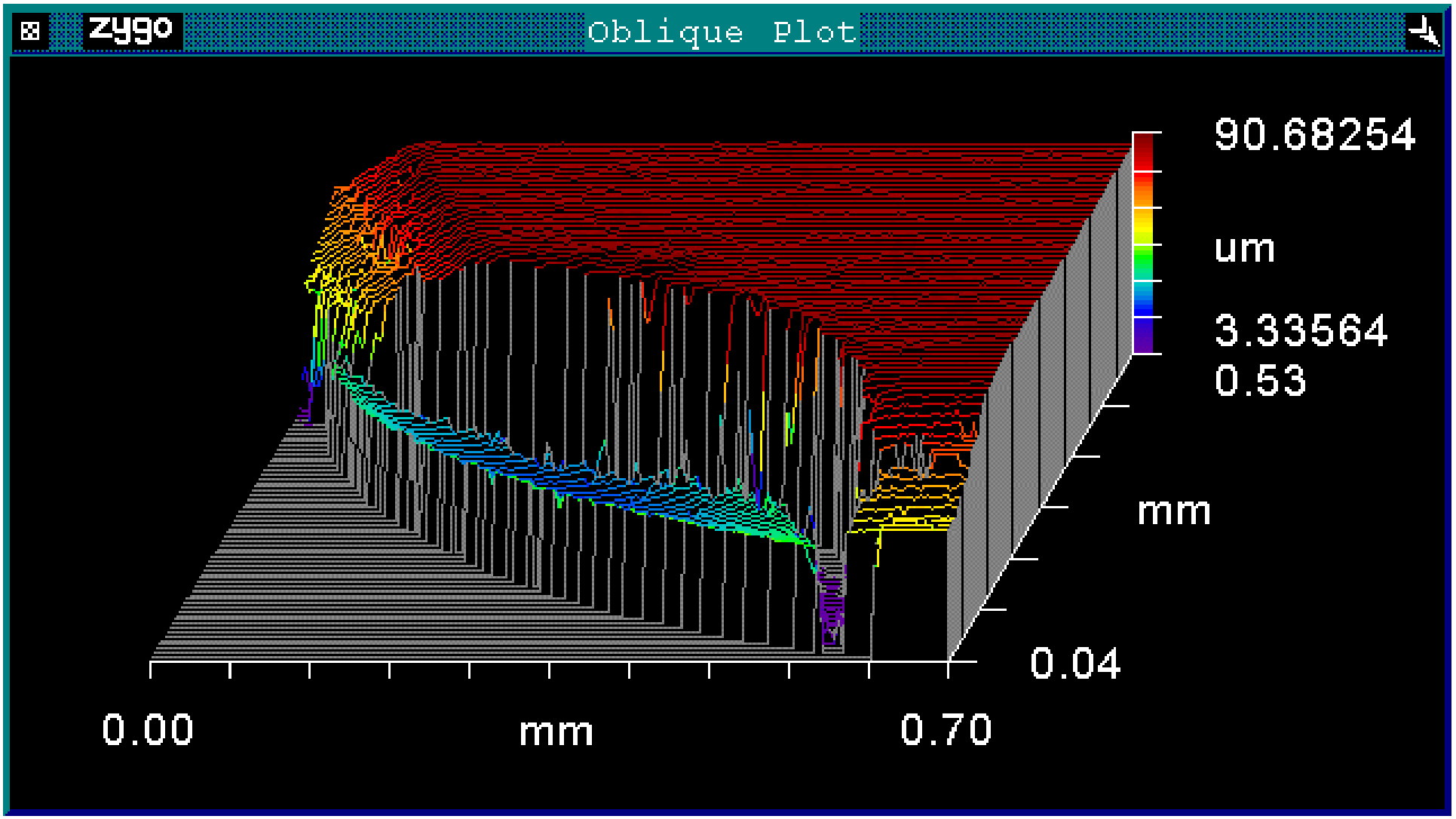

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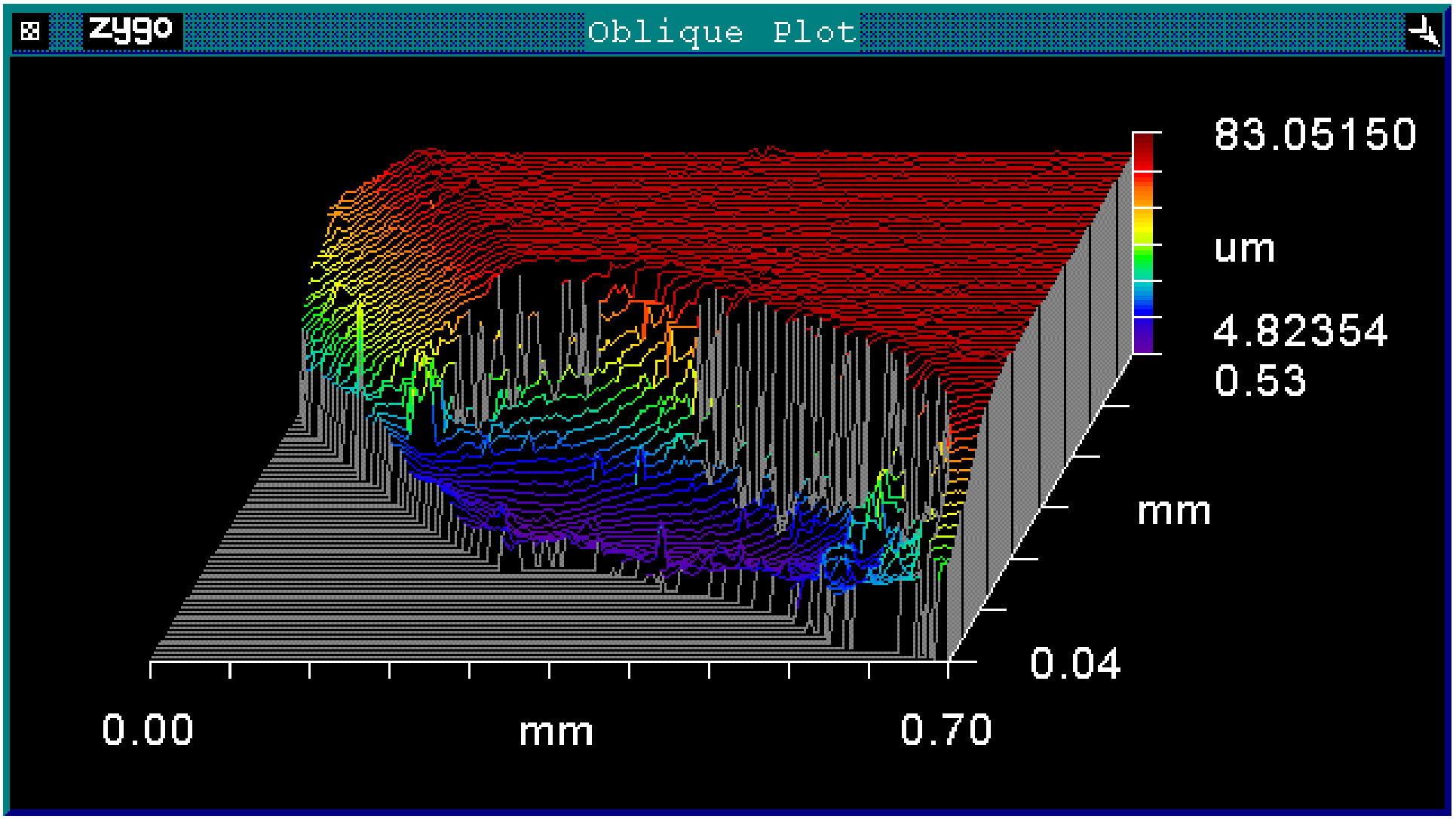
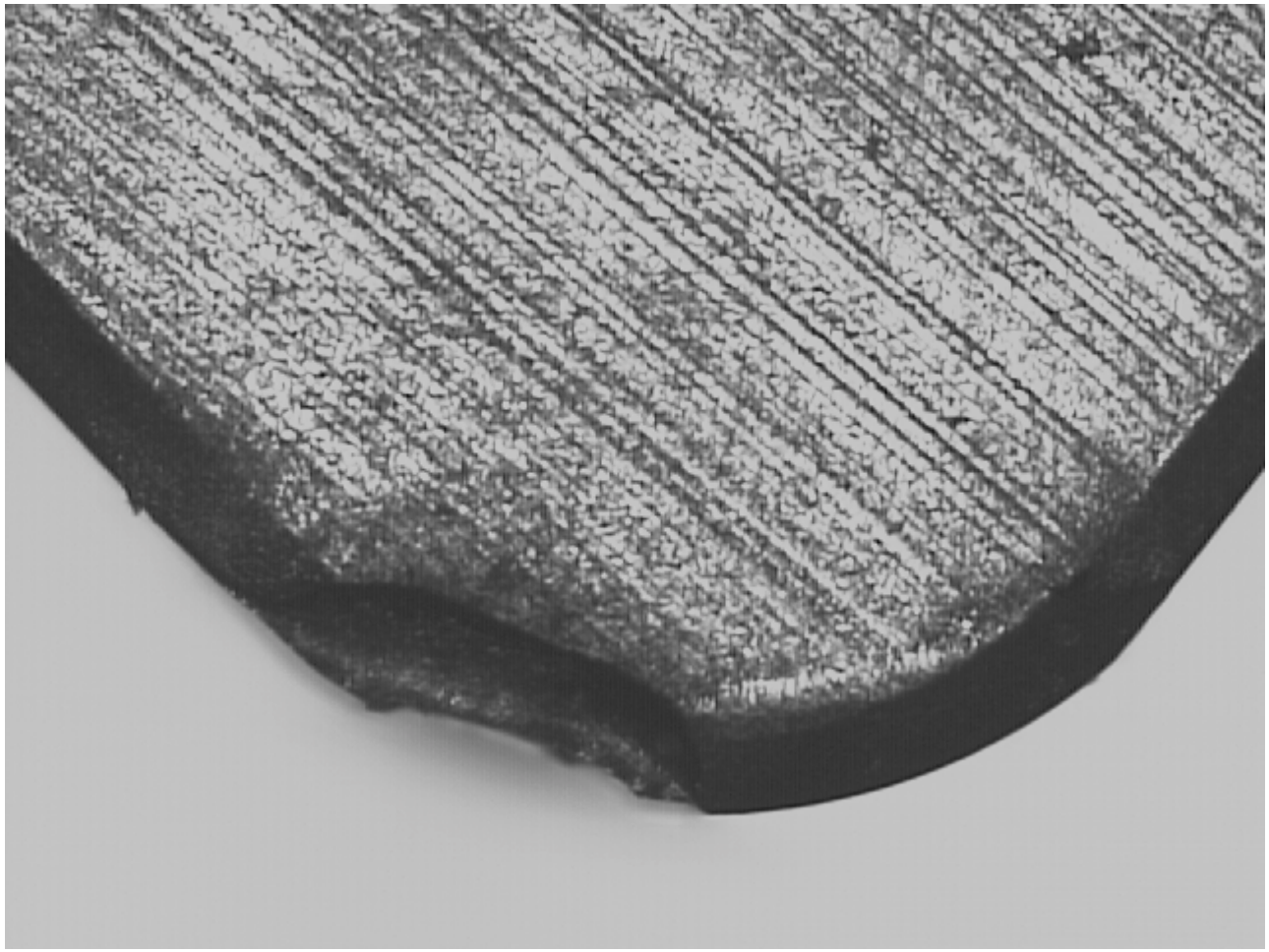
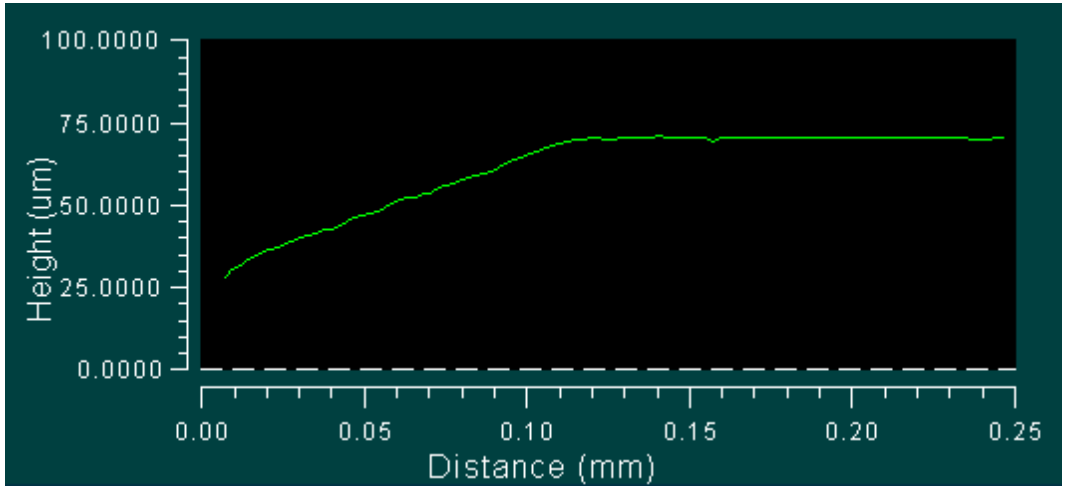


Tool Failure

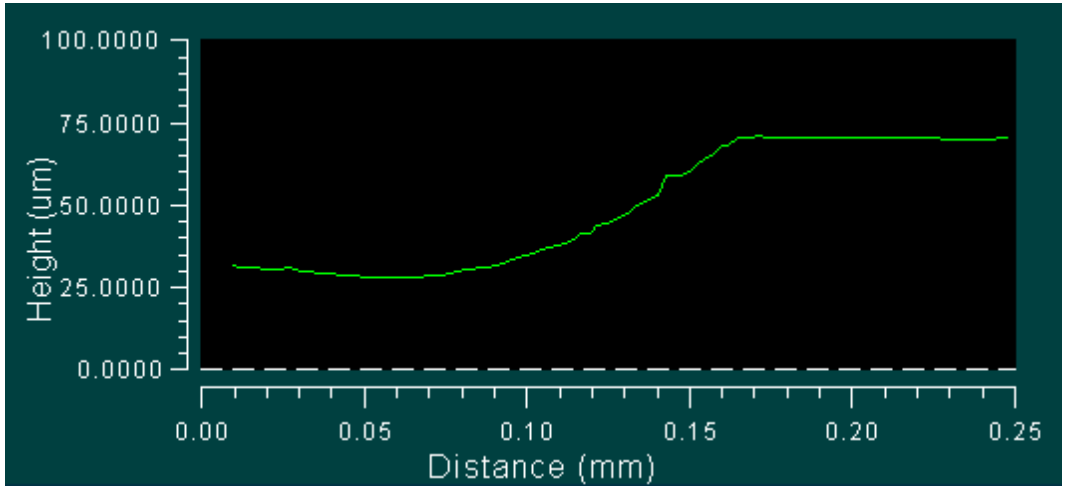


Changes in Cutting Edge Geometry

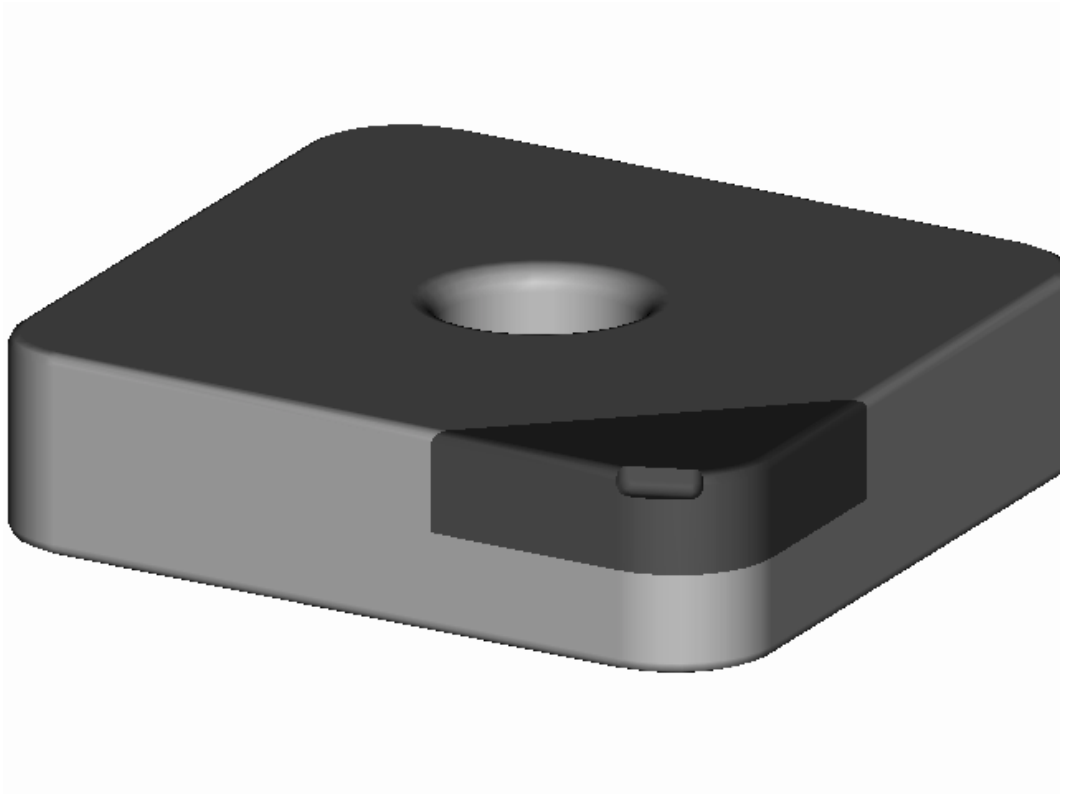
New Tool



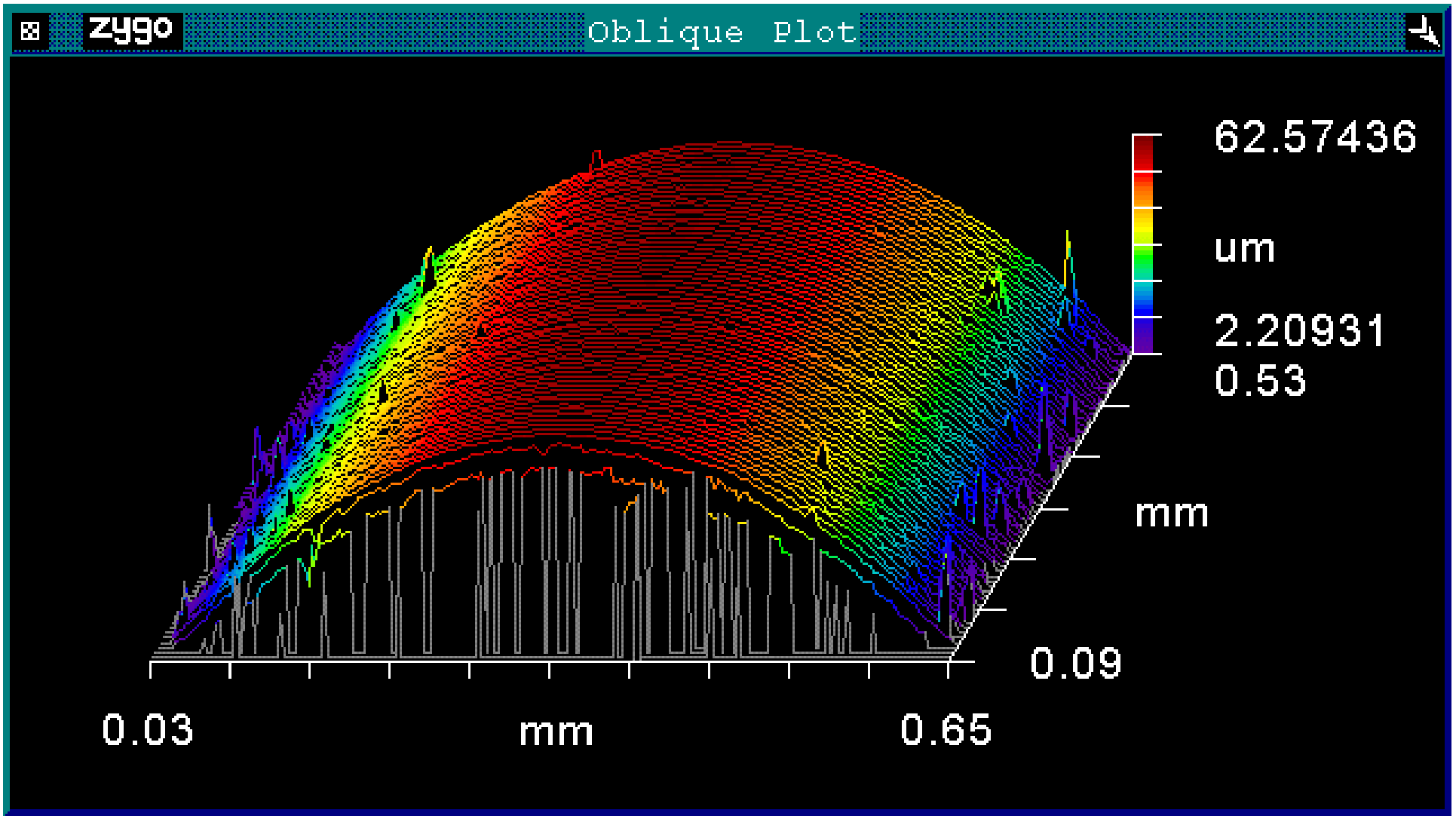
Pass 20



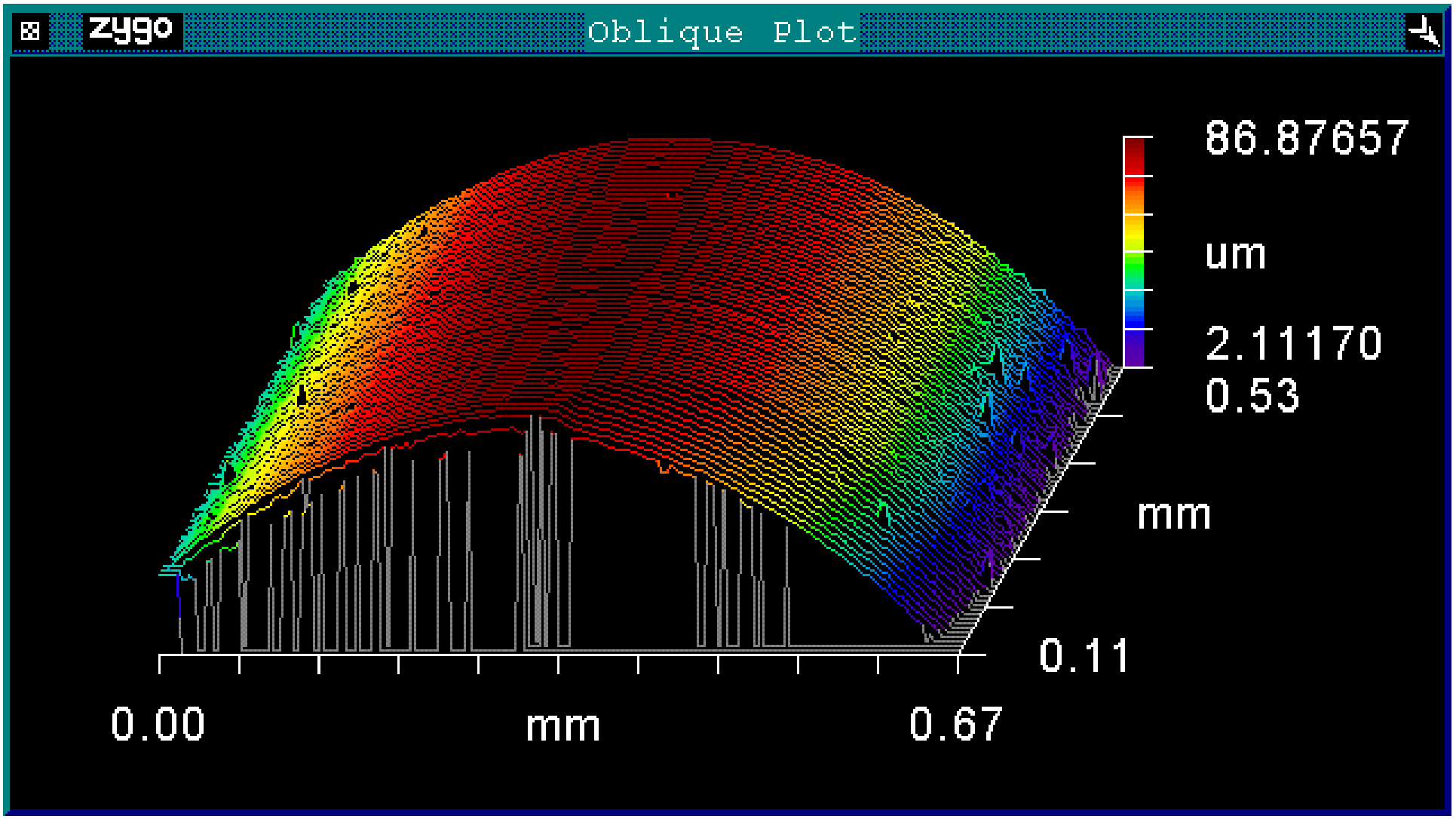
Flank Wear



Progression of Flank Wear



Progression of Flank Wear



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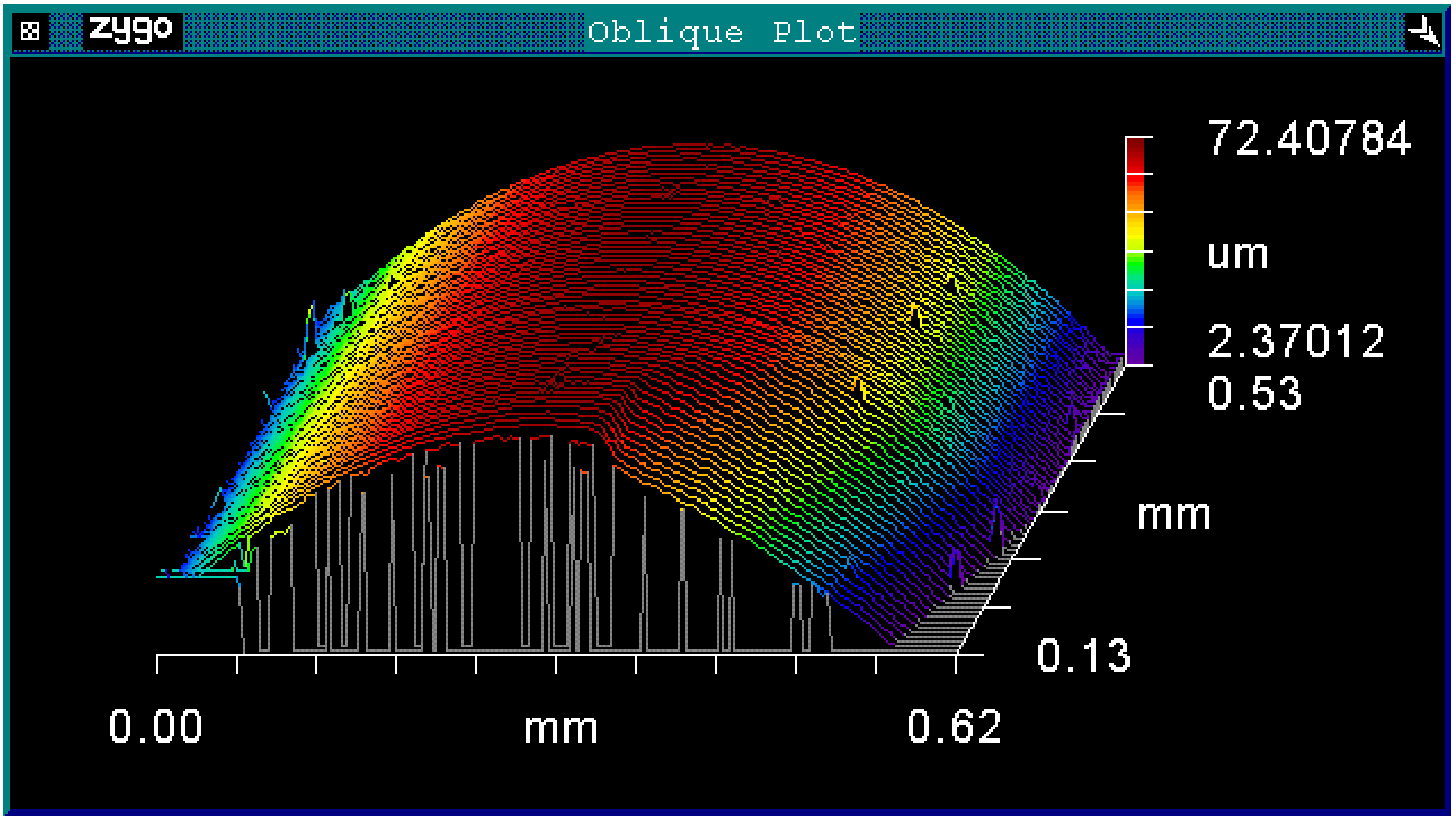
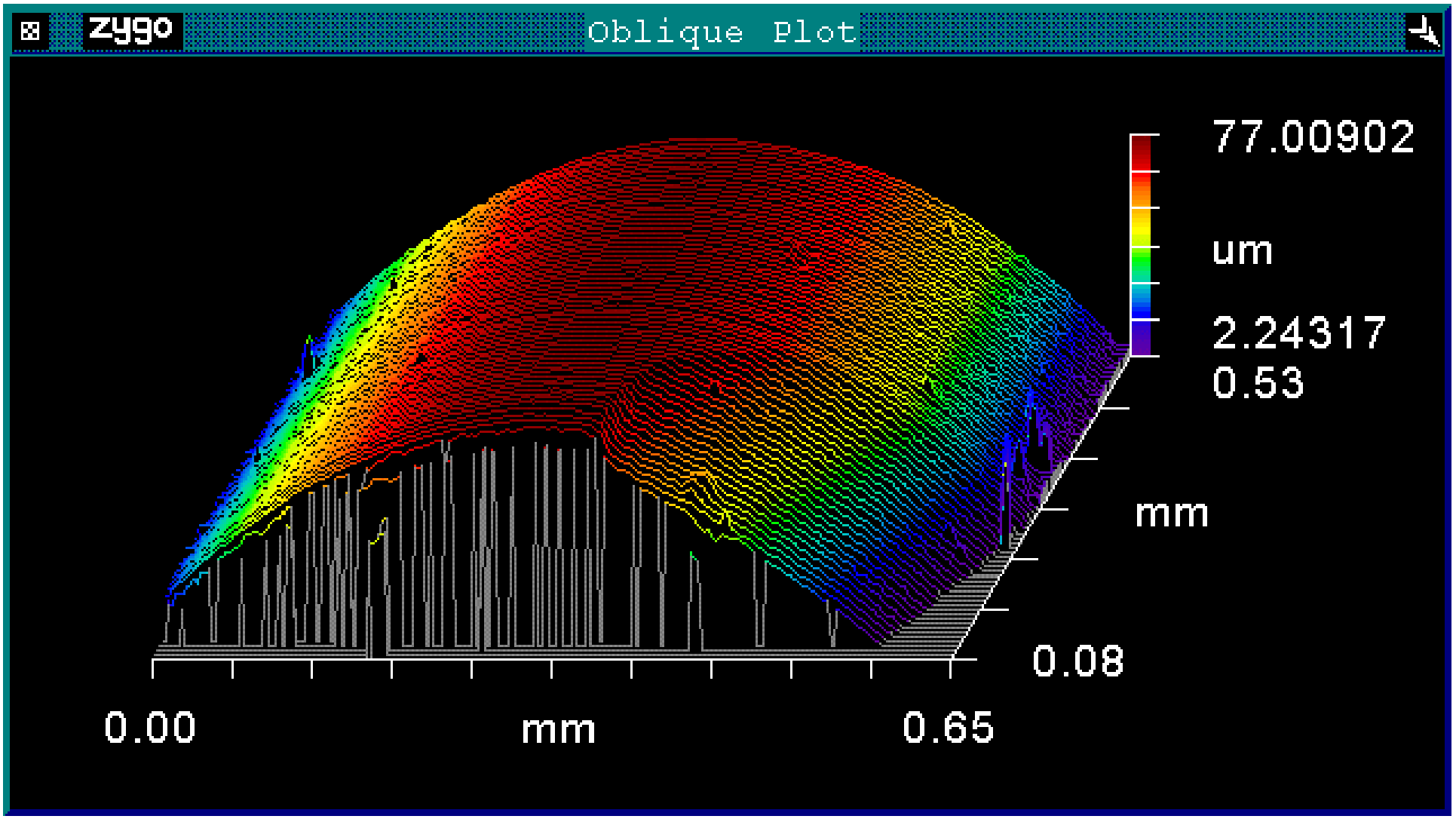
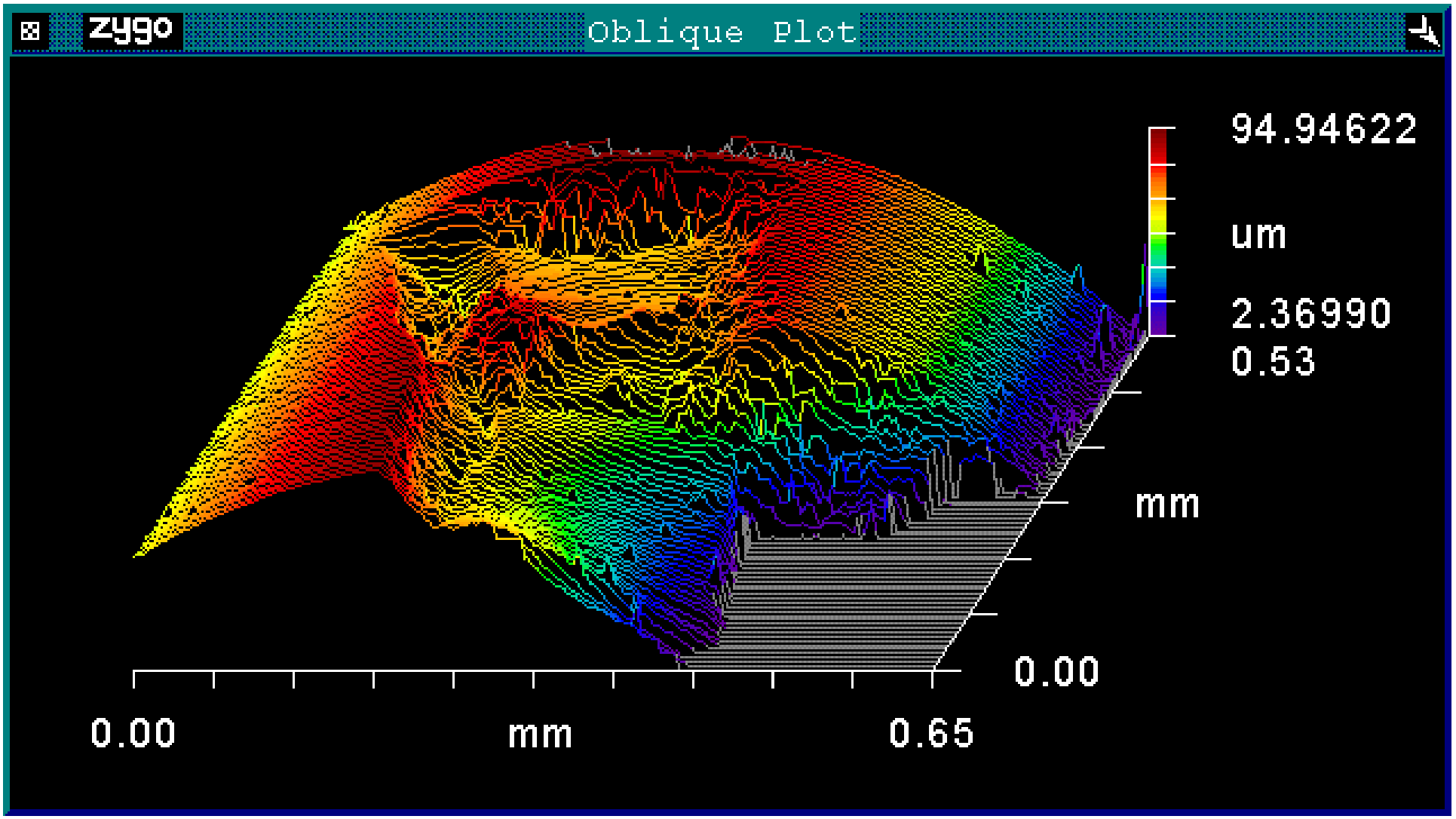


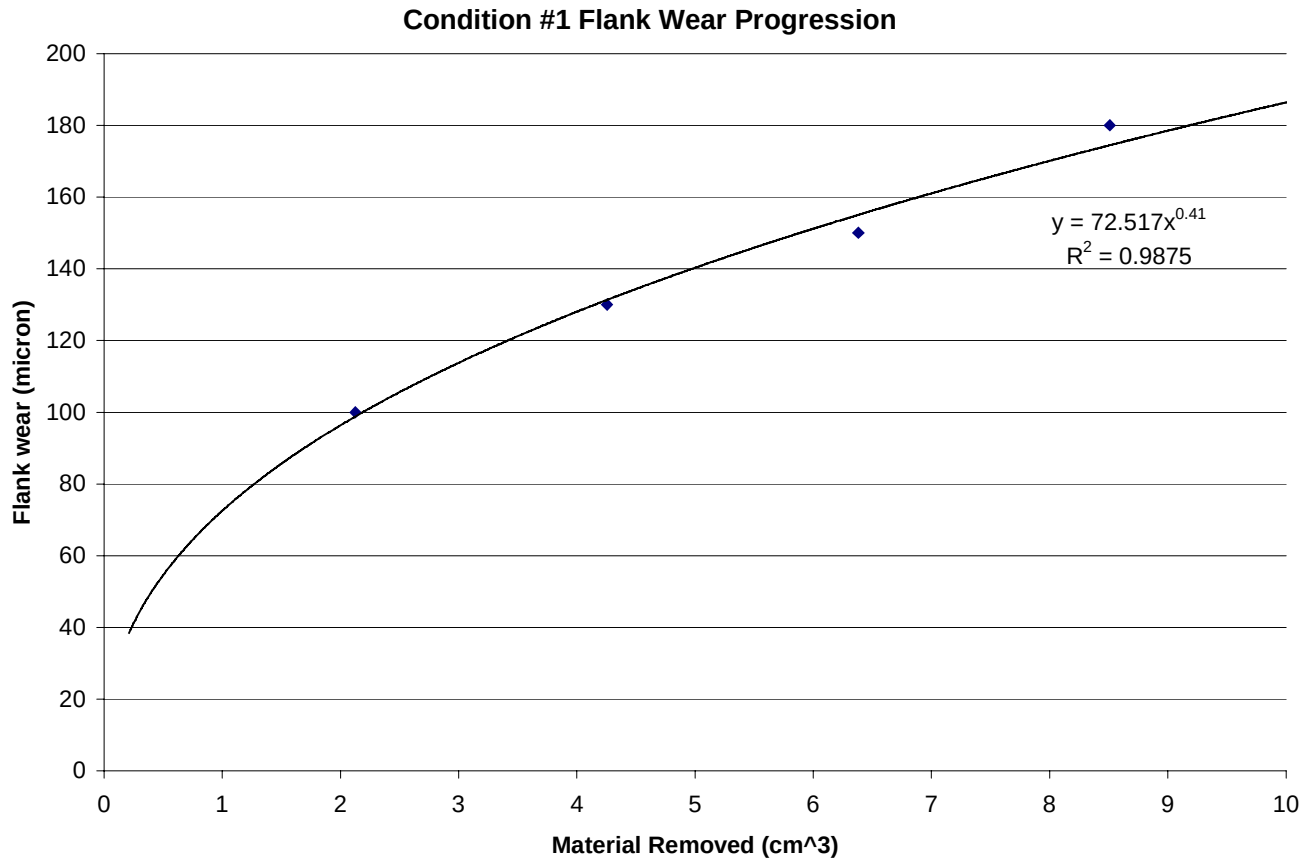
Progression of Flank Wear



Progression of Flank Wear



Rate of Flank Wear



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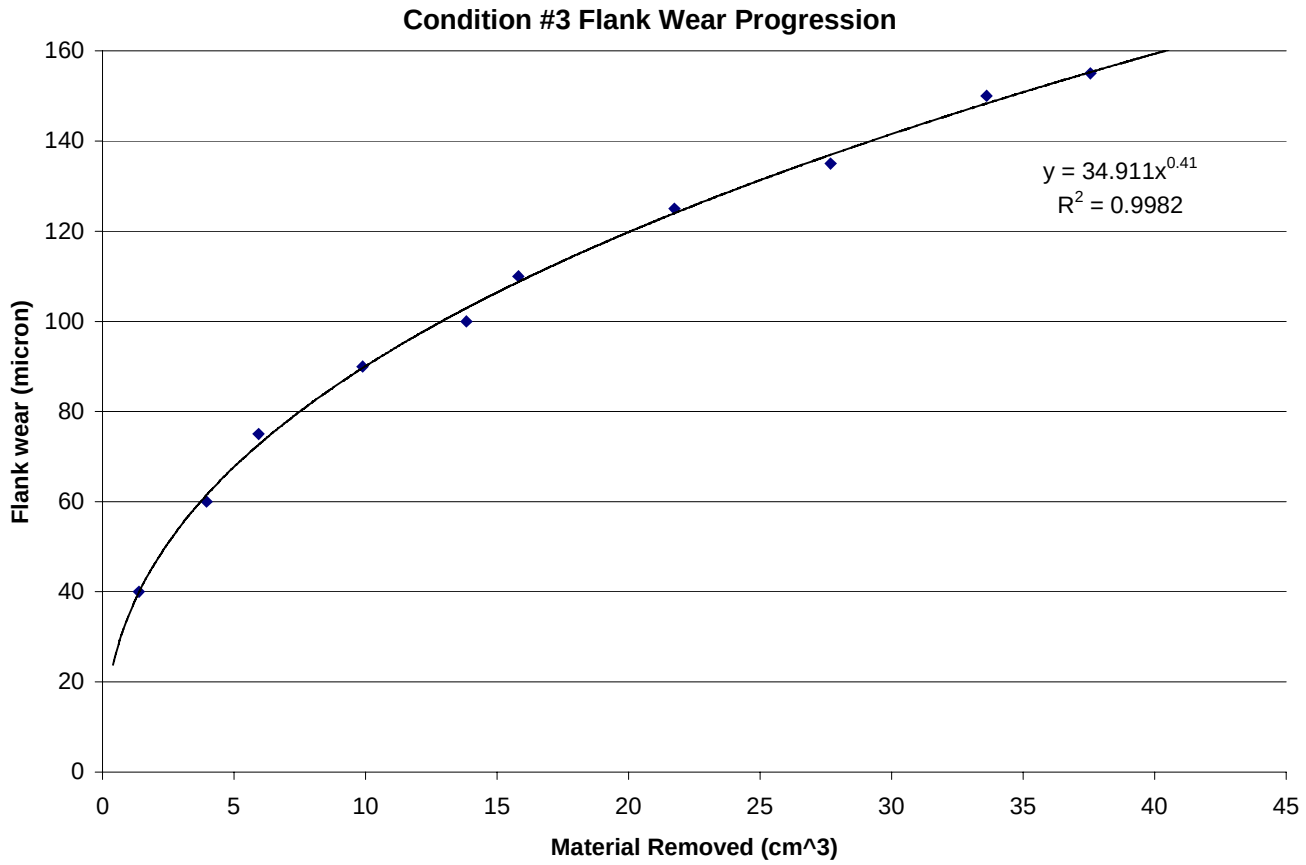

Conclusions

- The Zygo New View 200 provided a very powerful method for monitoring both crater and flank wear
- Because edge preparation is known to affect cutting results, a qualitative understanding of changes due to crater wear must be important
- Changes in cutting geometry due to crater wear were shown
- Maximum flank land for all conditions was found to be approximately 150 to 200 microns at failure
- A power-law relationship was found between flank wear and volume of removed material
- The cutting conditions appears to change the coefficient of this equation, which could provided a powerful method for determining tool life